ICT PANEL

WEB SURVEY WITH BRAZILIAN INTERNET USERS

PERSPECTIVES ON THE DISPOSAL OF ELECTRONIC WASTE

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PERSPECTIVES ON THE DISPOSAL OF ELECTRONIC WASTE

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The indicators presented here are considered experimental, as they use methodologies under development. More information on the methodological design of the survey can be accessed in the "Methodological Report", available on Cetic.br|NIC.br's website (www.cetic.br).

PRESENTATION

Over the last few decades, the Internet has been essential for ensuring, among many other things, communication, access to information, e-commerce, the provision of public services, telemedicine, remote working, distance learning, and cultural entertainment.

Given the centrality of information and communication technologies (ICT), monitoring their adoption is fundamental for evidence based policy making. Knowing how the population is using the Internet is important not only for understanding how they get information and communicate, but also how this use relates to their well-being.

With the aim of exploring topics that have not yet been explored in traditional surveys, the Regional Center for Studies on the Development of the Information Society (Cetic.br), a department of the Brazilian Network Information Center (NIC.br), linked to the Brazilian Internet Steering Committee (CGI.br), implements the ICT Panel, a survey conducted with Internet users through questionnaires answered via the Web.

The survey investigates activities carried out on the Internet and the devices used to access it, using the indicators from the ICT Households survey as a reference. In addition, it includes innovative themes that are still little explored in sample surveys about ICT adoption.

In this edition of the ICT Panel, the topic of electronic waste disposal was investigated, which covers the understanding of the concept, ownership of electronic devices, and habits related to disposal.

With this new survey, Cetic.br|NIC.br reaffirms its commitment to providing the government and society with robust and up-to-date statistics on the information society. It therefore seeks to accelerate the collection and availability of quality information on the use of ICT, offering relevant inputs for evidence-based public policies and seeking to promote the well-being of the population.

HIGHLIGHTS

E-WASTE CONCEPT

For most Brazilian Internet users, the concept of "electronic waste" is related to digital aspects, such as storing temporary files that take up space on devices, unwanted messages, spam, and advertising. Only 29% related the concept to electronic equipment that needs to be disposed of.

29%

OF INTERNET USERS RELATED THE CONCEPT TO ELECTRONIC EQUIPMENT THAT NEEDS TO BE DISPOSED OF

INOPERATIVE DEVICES

Among Internet users, 1 in 4 had electronic devices that were not working or in use. Of the categories of devices investigated, the highest proportions of devices that were not working or in use in relation to those owned were "videocassette, CD, DVD, or Blu-ray players" (1 in 3), followed by "desktop computers" (1 in 4), and "printers or scanners (1 in 5). The proportion of Internet users in class C and those who live in rural areas reached levels higher than the average of ownership of electronic devices that are not functioning among all the categories investigated.

1 IN 4

INTERNET USERS HAD ELECTRONIC DEVICES THAT WERE NOT WORKING OR IN USE

MOBILE PHONE

Regarding mobile phones, 32% of Internet users had second-hand mobile phones. This proportion reached 41% among those between 16 and 24 years old, 42% among those living in households in classes DE, and 40% among those out of the workforce. When it comes to exchanging their phones for new devices, 68% of Internet users justify doing it by situations related to obsolescence: "because the previous device broke", "because of the battery in the previous device", and "because the previous device did not run an app." Among Internet users with a higher level of education, these motivations are lower (59%), and the proportion of those who replaced their device "because they wanted a new mobile phone" is higher than average (23% among those with higher education, which represents 14% of the total).

32%

OF INTERNET USERS HAD SECOND-HAND MOBILE PHONES

DISPOSAL OF DEVICES

Among Internet users, 43% have disposed of an electronic device in the last 12 months. Of the categories surveyed, the most frequently discarded was mobile phones (25%), with 8% disposing of them in ordinary or recyclable waste, 8% handing them in at an e-waste collection point, and 6% giving them away or selling them to other users.

It is common for devices that are still functional to be discarded, as 8% of Internet users have discarded working mobile phones and 17% have discarded mobile phones that were no longer operational.

43%

OF INTERNET USERS HAVE DISPOSED OF AN ELECTRONIC DEVICE IN THE LAST 12 MONTHS

INTRODUCTION

The increasingly broader use of electronic devices by individuals and organizations has intensified the circulation of such devices, which, are also the source of a growing challenge: the inadequate disposal of electronic devices that are no longer useful or used. So-called electronic waste (e-waste) presents several potential harms to the environment and human health, which involve both harmful gases in the ozone layer and toxic metals in the soil and water tables, such as mercury and lead (Brazilian Network Information Center [NIC.br], 2019).

In recent decades, there has been an increase in the production of e-waste, not only in Latin America, but also across the world. The United Nations (UN) emphasizes this alarming scale-up, alerting us to the substantial and multifaceted impacts of this phenomenon. One relationship that is more evident in terms of the management of e-waste can be seen in Sustainable Development Goal (SDG) number 12, regarding responsible consumption and production. Furthermore, the issue can also be analyzed from the perspective of other objectives, such as SDG 8, about decent work and economic growth; SDG 3, about good health and well-being; SDG 6, about access to clean water and sanitation; and lastly, SDG 14, about life below water (Wagner et al., 2022).

Within the SDGs, some of the indicators that monitor responsible consumption and production are 12.5.1 (National recycling rate) and 12.4.2 (Hazardous waste generated) (NIC.br, 2019). Considering that the production of devices generates a high demand for raw material, a relationship can also be established with indicators for "material footprint" (12.2.1) and about the domestic consumption of materials (12.2.2) (Wagner et al., 2022).

Adequate processing and prevention of the generation of e-waste require the active involvement of various players, such as the production sector, governments, consumers, and users. In this direction, waste management policies have an important role to play in defining the roles and responsibilities of these players. In Brazil, the Brazilian System of Reverse Logistics for Electronic Device Waste was established in 2019 based on a sectorial agreement between the Ministry of the Environment (MMA) and enterprises associated with the commerce and industry of electronics, determining goals for the adequate collection and destination of devices in specific collection points in the 400 most populated municipalities (NIC.br, 2019).

This edition of the ICT Panel investigated the perspective of citizens who are users of information and communication technologies (ICT) in relation to e-waste, specifically equipment and devices related to ICT (such as screens and computer or information technology [IT] equipment). Based on international references and advancements in the definitions of methodological standards about the production of e-waste in homes, the Regional Center for Studies on the Development of the Information Society (Cetic.br) carried out an experimental edition to produce estimates regarding the understanding of the concept, the number of devices, and their working conditions, in addition to the behavior of Brazilian Internet users regarding the disposal of electronic equipment.

METHODOLOGICAL SUMMARY

INTERNATIONAL METHODOLOGICAL GUIDES AND THEMATIC REFERENCES

The main reference for the production of statistics on e-waste comes from *E-waste Statistics*, a report produced by the Task Group on Measuring E-Waste, of the Partnership on Measuring ICT for Development (Forti et al., 2018). The document establishes the main methodological guidelines and standardized definitions about what to measure and how, in addition to categories of equipment and their relationship with other systems of classification, such as European norms and the Basel Convention, which regulate the processing and movement of hazardous waste from the international perspective (United Nations Environment Programme [UNEP], 2019).

With the goal of increasing the availability of data originating from household surveys, between 2018 and 2023, the Expert Group on Household Indicators (EGH) of the International Telecommunication Union (ITU) maintained a sub-working group about e-waste indicators. During the group's annual meeting in September 2023, a proposal that summarizes the work of this subgroup was approved: A summarized set of reference indicators for ICT household surveys was established, addressing topics such as equipment disposal, the destination of discarded equipment, the origin of second-hand equipment, years of ownership of equipment, and the reason for the disposal of equipment (ITU, 2023). The list of equipment categories encompassed screens and computer or IT equipment.

Cetic.br|NIC.br participated in the subgroup responsible for this methodological guide, which contributed to the definition of indicators included in the recommendation. However, the definition of the indicators and of the survey questionnaire was concluded before the final approval of the international framework. Thus, of the five topics suggested, only four were included in this survey. Other topics are present in the survey questionnaire even though they are not part of the composition of indicators defined for international comparison. In some cases, the answer categories used were more detailed than those in the international framework. Ultimately, the list of categories of equipment was similar.

One of the international references that guided the present survey was the Canadian *Households and the Environment Survey* (HES) of 2021, which investigated the presence of devices in homes that were not used and not disposed of, in addition to emphasizing their sale, repair, and donation as forms of giving destinations to equipment that was not being used (Statistics Canada, 2022).

In Brazil, one of the managing entities of the reverse logistics system for electronic equipment (Green Eletron), in partnership with the Brazilian Association of the Electric and Electronic Industry (Abinee), carried out a study about the perceptions and habits of Brazilians regarding the disposal of electronic equipment (Green Eletron & Radar Pesquisas, 2021). This study found out that there were important misunderstandings among Brazilians regarding the term "e-waste", in terms of both lack of knowledge and its association with virtual waste such as spam and cookies. This factor was also considered in the international forum so as not to include awareness of the topic in the reference indicators.

ICT PANEL METHODOLOGY

The ICT Panel survey collects data from Internet users via web questionnaires. The respondents make up a non-probability quota sample that is weighted by estimating pseudo-weights for non-probability samples. The reference for constructing the pseudo-weights was the most recent ICT Households survey – in the case of this edition, ICT Households 2022 (CGI.br, 2023).[1]

The target population of the survey was Internet users 16 years old or older across Brazil. With each round of the survey, the representativeness of the sample of respondents was assessed, following the methodology for weighting non-probability samples, with reference to probability samples for the same target population.

A total of 2,515 panelists participated in the survey. During the process of weighting the respondents, it was observed that this sample represented a specific portion of the survey's target population: Internet users with higher levels of education, those who were young, and those from higher social classes. Of the 132 million Internet users estimated by the ICT Households 2022 survey (CGI.br, 2023), 113 million were represented by the respondents of this survey. Therefore, the estimators, tables, and analyses correspond to this new target population.

ANALYSIS OF RESULTS

PERCEPTION ON THE CONCEPT

The first dimension investigated by the survey explored the understanding of the concept "e-waste" among Internet users. To better comprehend the practices related to the disposal of e-waste, an open-ended question was included in the survey. The answers were analyzed and coded into broad categories, allowing for an understanding of which domains people refer to when they think of "electronic waste".[2]

This categorization exercise of the open-ended question, whose methodology is described in Box 1, yielded four categories:

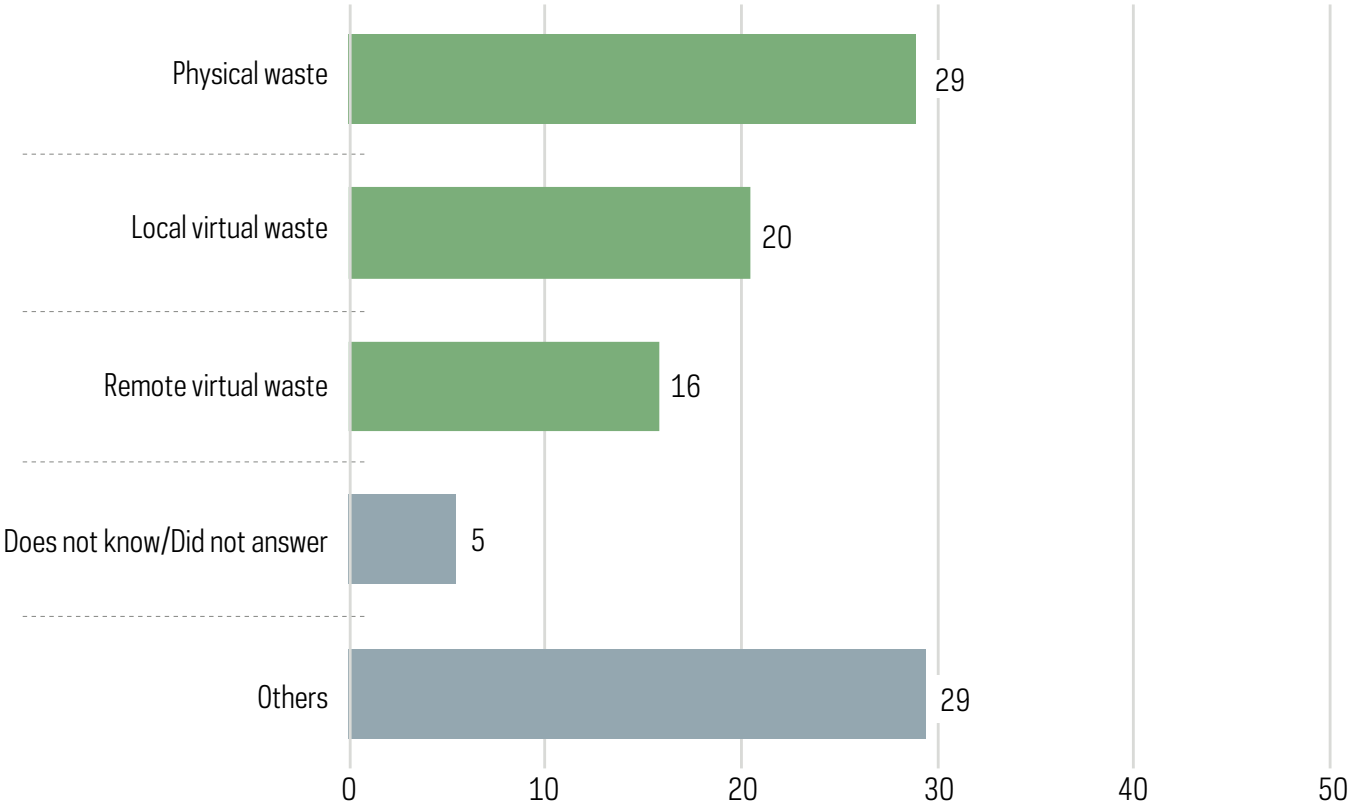
- Physical waste: electronic equipment and components to be disposed of ("computers", "laptops", "mobile phones", "small equipment and portable electronics", "batteries", "TVs/televisions").
- Local virtual waste: files stored in users' devices that are no longer useful ("temporary files", "what we delete and remains in the trash", "that which occupies space but has no use", "where you throw away apps, photos, videos").
- Remote virtual waste: files that are no longer on the users' devices and/or are sent without their consent by third-parties ("Internet trash", "deleted emails", "spam", "unwanted messages", "cookies or abusive advertisements").
- Others: a category that gathers very generic answers about that which is no longer useful or desirable, without clarity as to whether it relates to equipment, or local or remote files ("unnecessary things", "what no longer serves the user", "disposed of", "trash").

Chart 1 shows the results of this categorization, which indicates that there are at least three types of common answers to this question. Furthermore, there is a group of answers that are not associated with the "electronic" repertoire, but the "waste" repertoire, which emphasizes something disposable and with no use, appearing as "Others" in this categorization.

[1] For more information about the detailed methodology and data collection, see https://cetic.br/pt/pesquisa/tic-covid-19/publicacoes/

[2] The question posed to the respondents was: "In your own words, what do you understand to be 'electronic waste'?"

CHART 1: CATEGORIZATION OF THE CONCEPT OF ELECTRONIC WASTE (2022)
Total number of Internet users 16 years old or older (%)



That which is understood as e-waste, with potential hazards to human health and the environment, is in the first category ("Physical waste"). However, it is important to consider that for a good portion of Internet users, the term was understood as undesirable items in the digital sphere, not electronic. This group was further subdivided into the categories "Local virtual waste", regarding everything that is stored in devices, and "Remote virtual waste", regarding all types of undesirable items resulting from the browsing experience, ranging from spam to online advertisements. Together, the two categories of "Virtual waste" were mentioned more than "Physical waste" by Brazilian Internet users.

OWNERSHIP OF DEVICES

The survey also investigated the amounts of some categories of electronic devices owned by the population with the goal of understanding the number of devices that could be disposed of in the future. Chart 2 demonstrates the proportions of Internet users by ownership of electronic devices. As shown by the ICT Households 2022 survey (CGI.br, 2023), mobile phones and televisions were owned at much higher levels than other investigated devices.

BOX 1 - METHODOLOGY USED TO ANALYZE THE ANSWERS TO THE OPEN-ENDED QUESTION

To analyze the answers to the open-ended question, a supervised machine learning method was used to classify the texts into analysis categories. At first, a sample of 500 answers was selected randomly and categorized manually by a group of researchers.

To initiate the statistical analysis, the most common words of the Portuguese language (stop words), accents, and special characters were removed. Only the radicals of the remaining words were kept (stemming). Based on the new texts, descriptive analyses were carried out to identify possible terms common to various categories without substantive meaning, which were then also removed.

Given that some of the categories had a very low number of observations, they were then reduced using topic modeling (Chen et al., 2016). The best differentiation was obtained using four topics, which corresponded to an approximation to the used classifications, including the aggregation into "Others" for the more generic terms.

Given that the sample contained a reduced number of answers, it was necessary to take care with the analysis in order to not overadjust the model – i.e., to make sure that it didn't learn only about the answers classified manually and didn't generalize to the other answers. To this end, the researchers used a model that identified the parameter with better classification performance based on a cross-validation process.[3] In a process that increased the reliability of the model in the training model, the 500 sample answers were divided randomly, with four groups used as the training data and one as a test. The process was repeated ten times: In each repetition, the random distribution of the groups was different.

Based on the adjusted model, all the answers obtained in the survey were classified according to the technique. In the first step, point estimates were calculated for the proportions of each category, adjusting their respective weights in the set of answers. Next, to estimate the confidence intervals, 200 different sub-samples were used in a bootstrap process, a re-sampling method, with updated weights for each (Efron, 1979).

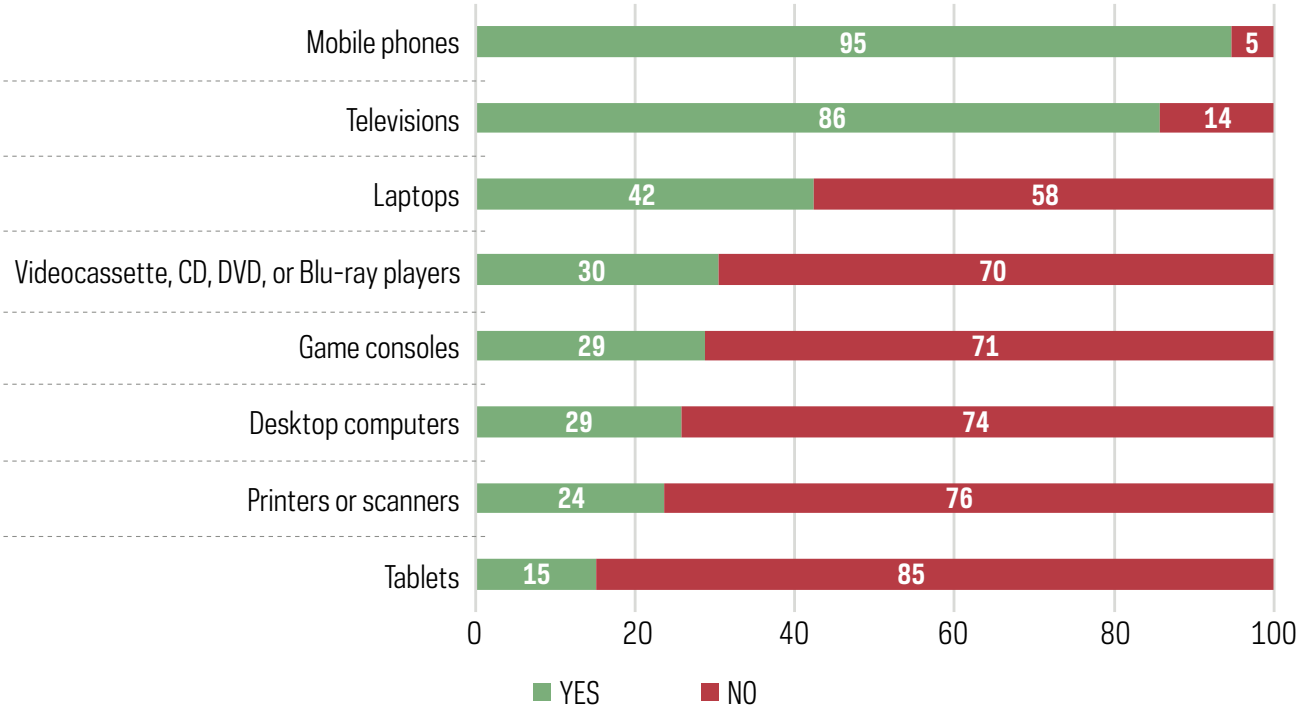
The categorization exercises of the open-ended answers generated four categories: "Physical waste", "Local virtual waste", "Remote virtual waste", and "Others".[4]

[3] Hyperparametrized Lasso models (Bertrand et al., 2020; Šehić et al., 2022).

[4] The "Does not know /Did not answer" and "Remote virtual waste" categories did not show great variation in the bootstrap process, generating smaller confidence intervals and point estimates close to the median. In turn, the categories "Physical waste", "Remote virtual waste" and "Others" showed greater variability in the process, with broad confidence intervals. However, the point estimate for "Local virtual waste" was close to the median, different from "Physical waste" and "Others", which were far above and far below, respectively, the medians of their distributions. This greater variation can have two explanations. In the first, the "Others" category was quite heterogeneous, containing answers that did not constitute relevant groupings for disaggregation. The second explanation is related to the "Local virtual waste" and "Remote virtual waste" categories, which sometimes had very subtle distinctions even in manual classification.

CHART 2: INTERNET USERS BY OWNERSHIP OF ELECTRONIC DEVICES (2022)

Total number of Internet users 16 years old or older (%)

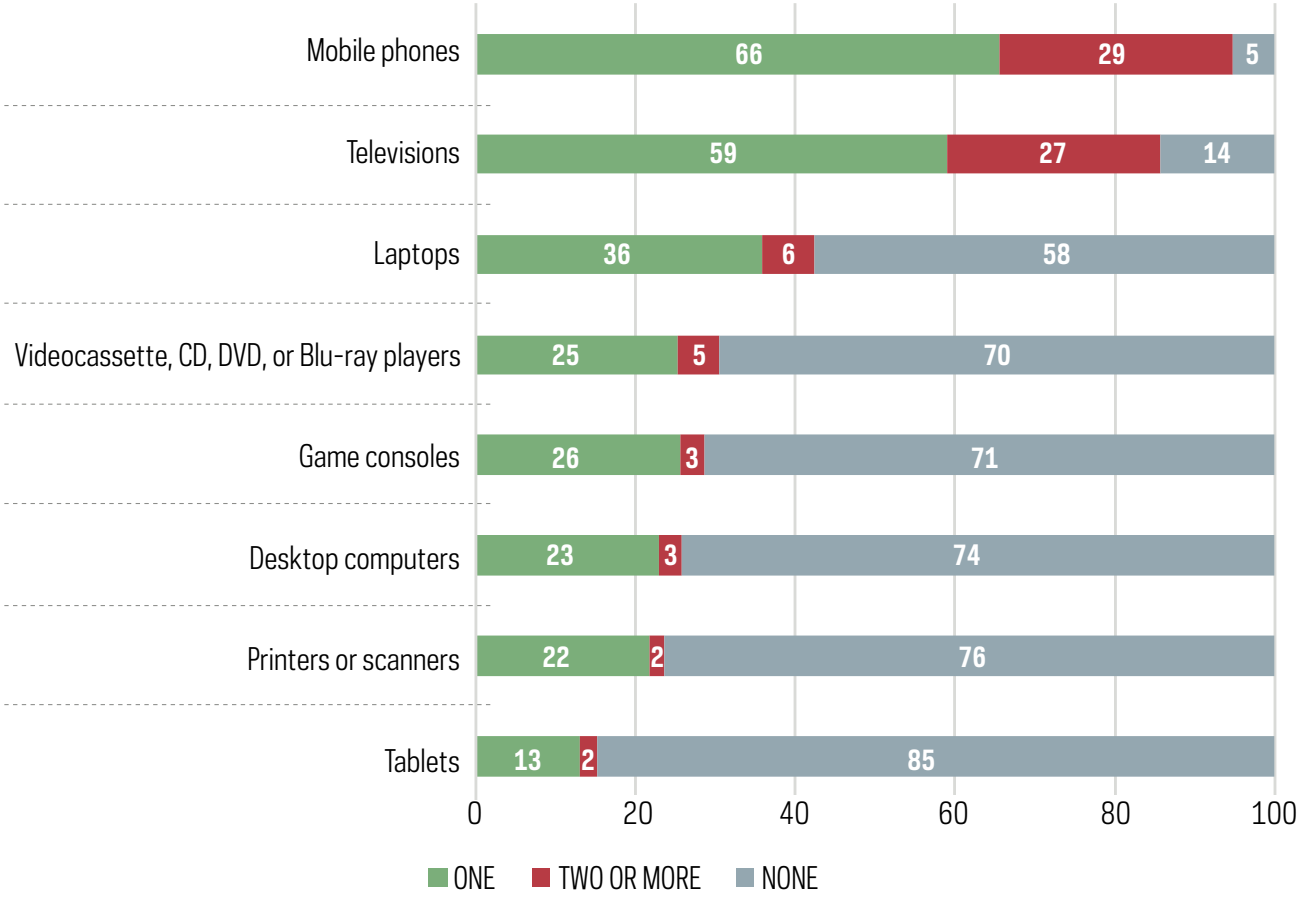


Among the crossed variables, emphasis goes to the level of education. Individuals with up to an Elementary Education had a lower proportion than others for the ownership of mobile phones. The ownership of the types of computers increased according to the level of education. Among the other types of devices investigated ("game consoles", "printers or scanners", and "videocassette, CD, DVD, or Blu-ray players"), individuals with a Tertiary Education had the highest ownership compared to the other Internet users.

For those who answered that they owned devices, they were also asked how many. As in the indicator for ownership, there was a relevant difference in the number of electronic devices owned according to category. The "mobile phones" and "televisions" categories, which had the highest incidence, presented higher proportions for Internet users with two or more devices. For the other devices, it was uncommon for there to be more than one device. This information is summarized in Chart 3.

CHART 3: INTERNET USERS BY NUMBER OF ELECTRONIC DEVICES OWNED (2022)

Total number of Internet users 16 years old or older (%)



The same trends identified in the ownership indicator were also found in the number of devices owned: The greater the level of education, the more devices owned. This behavior was also found among classes A and B. Last, female Internet users also reported higher numbers than male users.

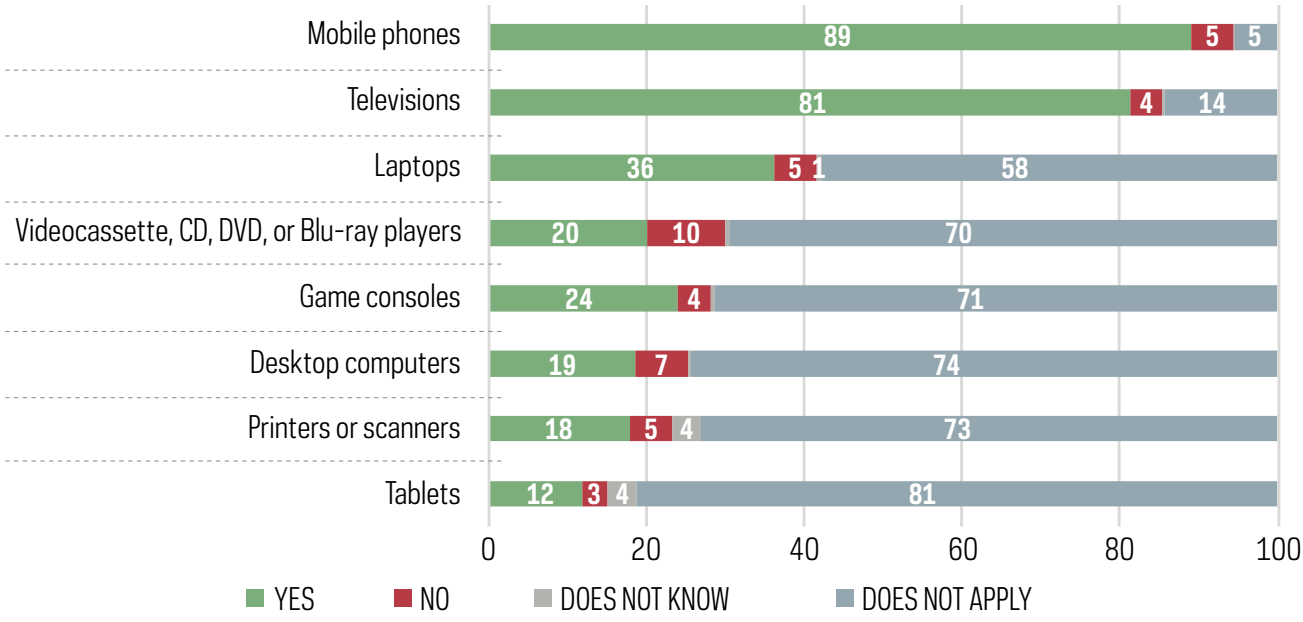
Furthermore, the survey also investigated the proportion of users who had second-hand devices, i.e., devices that were not bought or new, but came from another person who had already used them. In this category, emphasis goes to mobile phones (32% of Internet users reported having second-hand mobile phones) and televisions (20%). The proportion of those who had obtained these devices second-hand was higher among Internet users in classes DE and those between 16 and 24 years old.

WORKING SITUATION AND EXCHANGE

Internet users were also consulted about the working or use conditions of their devices. As shown in Chart 4, for all the device categories, there was a fraction that was not working or in use.

CHART 4: INTERNET USERS WHO OWN ELECTRONIC EQUIPMENT, BY WORKING AND USE CONDITION (2022)

Total number of Internet users 16 years old or older (%)



BOX 2 - CONCEPTUAL DISTINCTION BETWEEN ESTIMATES

As it was guided by the analysis unit "Internet users", this investigation presents a conceptual distinction in relation to surveys with the analysis unit "Household" (like ICT Households), which results in differences in estimates among surveys. While in ICT Households devices such as laptops and televisions are considered household devices, in this edition of the ICT Panel, these devices are considered as owned by the responding individual.

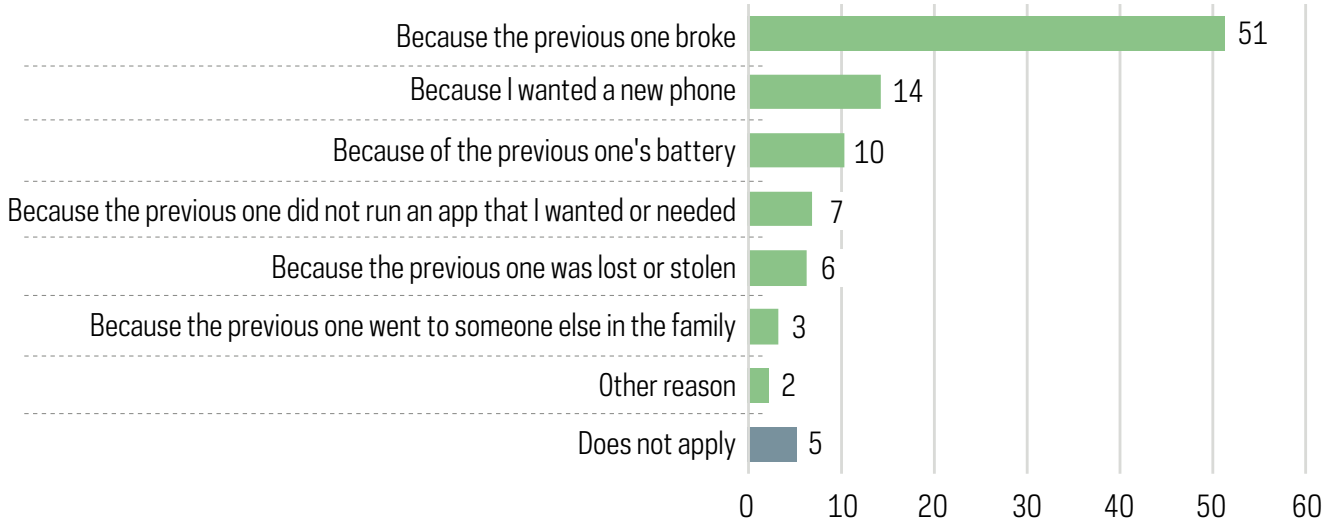
Using the estimate of televisions as an example, while the ICT Households 2022 survey (CGI.br, 2023) estimated that 95% of households had televisions, which corresponds to an estimated 71 million households, in the ICT Panel edition, an estimated 86% of Internet users had televisions, which corresponds to 97.2 million Internet users. In another example, the ICT Households 2022 survey (CGI.br, 2023) showed that 28% of households had laptops (21.1 million households), while the ICT Panel estimated that 42% of Internet users had laptops (48 million Internet users). With regard to mobile phones, the ICT Households survey presented estimates for individuals 10 years old or older in 2022 in which 88% of individuals (163 million) had mobile phones. In the ICT Panel, in turn, an estimated 95% of Internet users 16 years old or older (107 million) had these devices.

Considering all the product categories investigated, the proportion of Internet users who had at least one device that did not work was 25%. Proportionally, the categories with the greatest incidence of devices that were non-functioning or not being used were "videocassette, CD, DVD or Blu-ray players" (1 out of 3), followed by "desktop computers" (1 out of 4) and "printers and scanners" (1 out of 5). The proportion of Internet users of class C and of those who live in rural areas reached levels higher than the average of ownership of electronic devices that are not functioning among all the categories investigated.

Specifically in the case of mobile phones, given that they are the electronic devices with the greatest incidence in the Brazilian population, the users were also asked about the main reason why they had exchanged their last device (Chart 5). Among the answer options, there were three that described situations related to the product's obsolescence: "because the last one broke", "because of the previous one's battery", and "the previous one did not run an app". Altogether, these three alternatives reached 68% of Internet users.

CHART 5: INTERNET USERS BY REASONS FOR EXCHANGING MOBILE PHONE (2022)

Total number of Internet users 16 years old or older (%)



Among the Internet users with higher education levels and those in a higher social class, the proportion of those who exchanged their devices because they wanted new phones was higher than the others. This behavior was also related to age group, with higher proportions among those 45 years old or older.

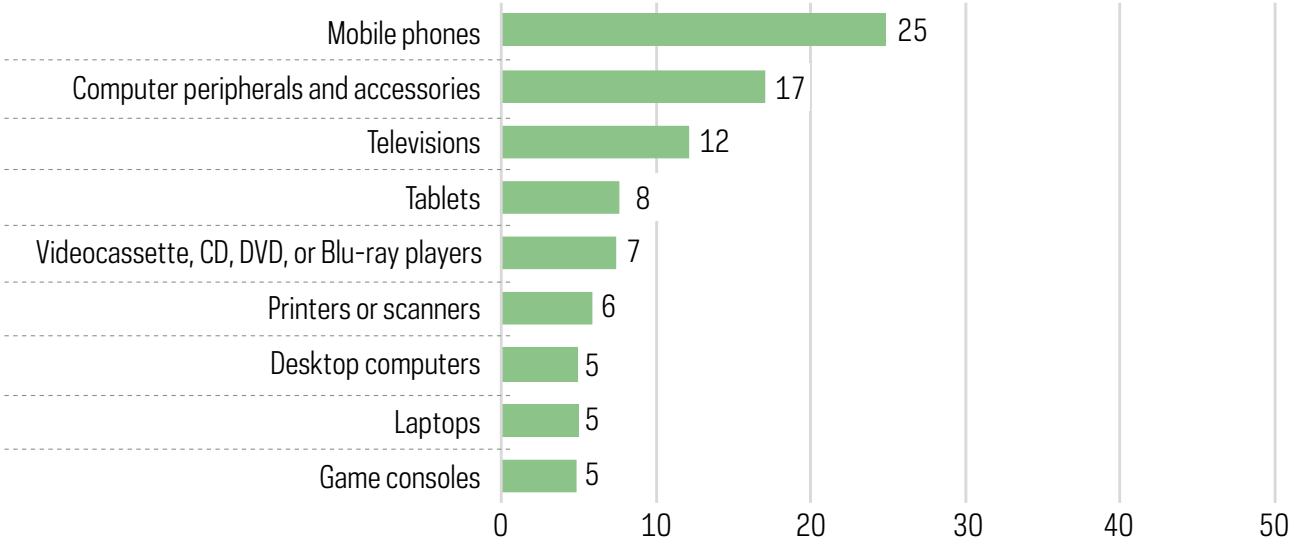
For those who exchanged their devices because of one of the three reasons related to obsolescence, the emphasis goes to those who had up to an Elementary Education, those in classes DE, and those between 35 and 44 years old.

DISPOSAL OF ELECTRONICS

Internet users also answered a question about the disposal made in the last 12 months of each type of device they had. In relation to previous indicators, from this point in the questionnaire on, a category for computer peripherals and accessories was included. This category, in addition to mobile phones and televisions, was the most mentioned also in regard to disposal (Chart 6). Considering all the investigated product categories, the proportion of Internet users who disposed of at least one device in the last 12 months was 43%.

CHART 6: INTERNET USERS BY DISPOSAL OF ELECTRONIC EQUIPMENT IN THE LAST 12 MONTHS (2022)

Total number of Internet users 16 years old or older (%)



The proportion of those who discarded mobile phones was higher among individuals in class A and those 35 to 44 years old. The proportion for computer peripherals and accessories was higher among individuals in class A and those 60 years old or older. Some of the discarded equipment was still working upon disposal: 8% of Internet users disposed of mobile phones and 6% of televisions that were still working.

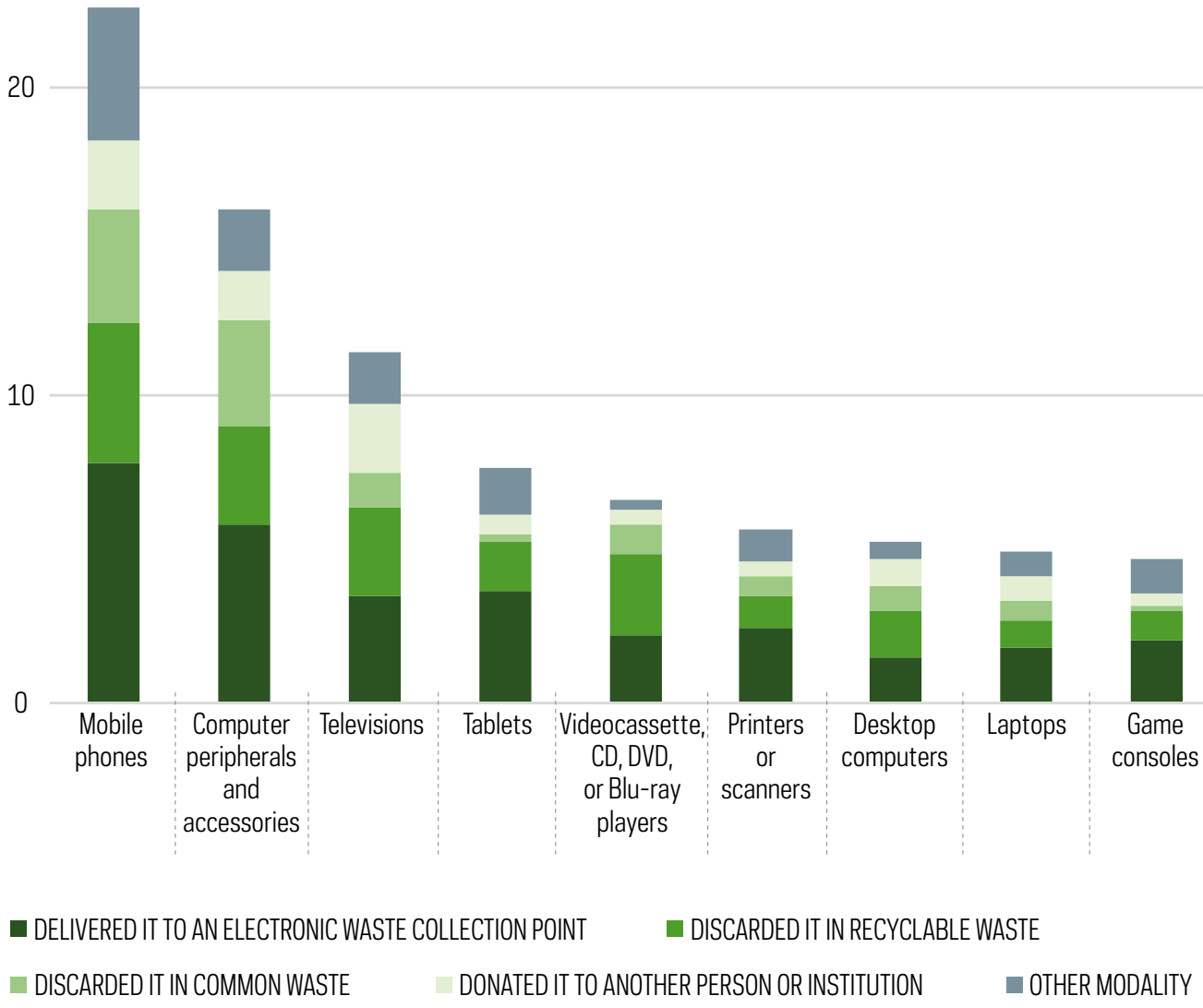
The survey also investigated whether the users who disposed of equipment had sent it for repair before disposal. Regarding mobile phones, 12% of Internet users sent them to repair once, 4% more than once, and 8%, never.

MODALITY OF DISPOSAL

Individuals who had disposed of a device were asked about the modality of disposal. Chart 7 lists the answer categories for each type of device disposed of.

CHART 7: INTERNET USERS WHO DISPOSED OF ELECTRONIC EQUIPMENT, BY MODALITY OF DISPOSAL (2022)

Total number of Internet users 16 years old or older (%)



The proportions of the main categories presented small differences within the margins of error of each estimate. It is possible to state that the most mentioned modalities were "discarded it in common waste", "discarded it in recyclable waste", and "delivered it to an electronic waste collection point". Selling mobile phones and donating various types of equipment were mentioned in lower proportions. The other categories were mentioned in even lower proportions.

FINAL CONSIDERATIONS

This first experience investigating aspects related to e-waste in Brazil allows for important reflections to improve policies and the production of knowledge in the field. It also contributes to the promotion of the methodology for measuring and producing statistics on the topic.

The survey showed that it is still necessary to increase awareness regarding the risks and potential hazards of e-waste, as the perception of a considerable part of the population about the concept can be both abstract and distorted by their experience with the digital universe. Another aspect in which this was reflected in the indicators was in the act of disposing of equipment along with regular waste, or disposing of equipment that is still in working condition.

It is evident that there is a stock of electronic equipment owned by Brazilian Internet users, especially telephones and televisions. Although a survey such as ICT Households can estimate the number of equipment with greater precision, it does not offer the possibility of mapping a wider range of devices, nor of detailing their working condition, their origin, and their destination. Thus, it is necessary to think of alternatives for producing data that enhance the capacity to take advantage of efficient and wide-reaching samples with questionnaire space suited to the complexity of the topic.

The production of detailed statistics about electronic waste plays an essential role in understanding the challenges associated with the issue. The data offer evidence for the development, honing, and monitoring of policies and their implementation. By quantifying the amount, origin, and composition of e-waste, statistics allow policymakers, researchers, and organizations to assess the efficacy of existing initiatives and identify specific areas that need priority intervention. Furthermore, these statistics are crucial to raising public awareness about the urgency of the problem. In a scenario in which the inadequate disposal of these materials negatively impacts ecosystems, communities, and resources, the production of reliable statistics is an indispensable instrument to promote a more sustainable future.

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ABOUT CETIC.br

The Regional Center for Studies on the Development of the Information Society (Cetic.br), a department of NIC.br, is responsible for producing studies and statistics on the access and use of the Internet in Brazil, disseminating analyzes and periodic information on the Internet development in the country. Cetic.br is a Regional Study Center, under the auspices of UNESCO. More information at https://www.cetic.br.

ABOUT NIC.br

The Brazilian Network Information Center – NIC.br (http://www.nic.br/) is a non-profit civil entity in charge of operating the .br domain, distributing IP numbers, and registering Autonomous Systems in the country. NIC.br implements the decisions and projects of the Brazilian Internet Steering Committee – CGI.br since 2005, and all the funds it collects come from its activities that are eminently private in nature. It conducts actions and projects that benefit the Internet infrastructure in Brazil. NIC.br is made up of: Registro.br (https://registro.br), CERT.br (https://cert.br/), Ceptro.br (https://ceptro.br/), Cetic.br (https://cetic.br/), IX.br (https://ix.br/) and Ceweb.br (https://ceweb.br/), as well as projects such as Internetsegura.br (https://internetsegura.br) and the portal Best Practices for the Internet in Brazil (https://bcp.nic.br/). It also hosts the Brazilian W3C office (https://w3c.br/).

ABOUT CGI.br

The Brazilian Internet Steering Committee, responsible for establishing strategic guidelines related to the use and development of the Internet in Brazil, coordinates and integrates all Internet service initiatives in the country, promoting technical quality, innovation and dissemination of the services on offer. Based on the principles of multistakeholderism, transparency, and democracy, CGI.br represents an Internet governance model in which all sectors of society participate equally in its decisions. One of its formulations is the "10 Principles for the Governance and Use of the Internet" (https://www.cgi.br/principios). More information is available at https://www.cgi.br.

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